

AN EVALUATION OF CROP PROTECTION METHODS IN KERALA¹A. VEERAMANI², P.S. EASA^{3,4} AND E.A. JAYSON^{3,5}¹Accepted January 2003²Periyar Tiger Reserve, Thekkady 685 536, Idukki, Kerala, India. Email: av_mani@rediffmail.com³Division of Wildlife Biology, Kerala Forest Research Institute, Peechi 680 653, Thrissur, Kerala, India.⁴Email: easa@wti.org.in⁵Email: jayson@kfri.org

Increasing incidence of crop depredation by wild animals have led to the use of several methods to protect crops in wildlife areas. An evaluation of the effectiveness of various protection methods used in 20 different Forest Ranges of Kerala between June 1994 and December 1994 is attempted, and the advantages and disadvantages of each discussed. Areas with crop depredation were visited to collect information on the methods employed for crop protection, their functioning and effectiveness. Guarding with ordinary fencing, stonewall fencing, line crackers, chemicals, trenches and electric fencing were the major control measures in practice. Electric fencing, though it required high initial investments, was the most effective against most of the animals.

Key words: Crop protection, electric fencing, wild animals, Kerala

INTRODUCTION

As the incidence of crop depredation by wild animals increases, so do methods to protect crops in wildlife areas. These methods could be effective for a long or short term, depending on the animal as well as the method used. Several control measures are used under different conditions and most researchers agree that the use of electric fencing and trenches are the most effective (Sukumar 1985, 1986; Schultz 1986, 1988; Santiapillai and Jackson 1990; Banerjee 1994; Chandrasekaran 1994; Shetty 1994; Bist 1996). Morris (1958) has mentioned the use of bamboo gun rocket for scaring away wild animals. Thorny branches of *Acacia* were used as brushwood fences in Haryana and Madhya Pradesh (Chauhan and Sawarkar 1989; Chauhan and Singh 1990). Use of trained dogs to chase crop-raiding deer was reported by Beringer *et al.* (1994). Swihart and Conover (1990) reported the use of big game repellent RO^oPEL and soap to reduce crop damage by deer. Recent reports from Zimbabwe mention the use of a capsicum-based aerosol as elephant repellent (Osborn 1998). However, its effect is short term and can be used only for short to intermediate ranges. The traditional methods for deterring crop-raiding elephants, such as fire, brush fences and sound making devices have generally failed, except when the animals are close (Bell and McShane-Caluzi 1984). Jayawardene (1994, 1995, 1997) reported the effectiveness of electric fences against crop-raiding elephants in Sri Lanka. Thouless and Sakwa (1995a, b) assessed the effectiveness of electric fences in Northern Kenya and suggested that they be backed by special protection.

A total of 1310 cases of crop damage by wild animals were recorded throughout Kerala between 1981-1994. A total

amount of Rs. 1,06,24,689 were claimed as compensation in the State for crop damage, of these Rs. 8.66,977 have been paid as compensation and form only 8.16% of the total claims (Veeramani 1998). Easa *et al.* (1998), Jayson (1998) and Veeramani (1998) have discussed the crop protection methods employed in Kerala. The present investigation evaluates the effectiveness of various protection methods employed in different parts of Kerala.

STUDY AREA

Kerala State, which lies in the southern part of the Western Ghats, is unique in environmental characteristics due to its geographical location (between 8° 18' and 12° 48' N and between 74° 52' and 77° 22' E) and topography. It is bounded on the eastern side by the Western Ghats ranges and to the west by the Arabian Sea. The state can be classified into three topographical regions, namely the coastal area, midlands and the highlands. The forest areas lie mostly in the highlands. The state has a forest cover of 9,400 sq. km (Anon. 1997). About 24% of the forest area lies within the protected area network comprising 12 wildlife sanctuaries and 2 national parks. The forest areas have been subjected to alterations of various degrees for agriculture, developmental programmes and settlements. Most of the forest areas have human habitations in the fringes and in some cases scattered settlements within. The majority of the settlements cultivate a variety of crops, which are prone to damage by wild animals. The agro-based economy of Kerala depends a lot on cash crops such as coffee, pepper, tea, cardamom and rubber, cultivated mostly in the highlands. The state has a good number of mammal species representing various taxa, such as Elephant (*Elephas maximus*), Gaur (*Bos frontalis*), Sambar

(*Cervus unicolor*), Chital (*Axis axis*), Wild Boar (*Sus scrofa*), Porcupine (*Hystrix indica*), and Bonnet Macaque (*Macaca radiata*).

METHODS

The study was carried out between June 1994 and December 1994. A total of ninety-five Territorial and Wildlife Ranges under five Forest Circles were considered for this study. Of these, four were selected randomly from each of the forest circles (Table 1). Two settlements with intensive crop depredation problems, one each in the enclosure and the periphery, were chosen in each of the selected Forest Ranges. These settlements were visited once and 1 km long transects laid, starting from the forest boundary. Plots of 10 sq. m were laid at every 100 m along the transect.

For each study plot, details of crop species in the plot, number of damaged and undamaged crop plants, phenology, animal causing the damage, nature of damage and protection method employed at the time of visit, were recorded. Enquiries were also made with the cultivators in the area to confirm the animal species involved in raiding, and other details such as the date and time of the raids. Care was taken to cover the areas within a single season and at the time of cultivation.

The damaged areas were visited, and details like crops damage, animal species involved, type of control measures, including the cost and efficiency of the method used, were recorded. Sample plots of 10 sq. m were laid to determine the efficacy of a method.

Table 1: Selected forest Ranges and its Divisions and Circles

Sl. No.	Range	Division	Circle
1	Kannavam	Kannur	Northern Circle
2	Kurichiat	Wynaad (WL)	
3	Kalpetta	South Wynaad	
4	Chedleth	South Wynaad	
5	Edavanna	North Nilambur	Olavacode Circle
6	Nelliampathy	Nemmara	
7	Attapadi	Mannarkad	
8	Agali	Mannarkad	
9	Chimmony	Chalakuudi	Central Circle
10	Vellikulangara	Chalakuudi	
11	Sholayar	Vazhachal	
12	Kollathirumedu	Vazhachal	
13	Marayur	Munnar	High Range Circle
14	Adimali	Munnar	
15	Idukki	Idukki	
16	Kaliyar	Kothamangalam	Southern Circle
17	Agasthyavanam	Trivandrum (WL)	
18	Palode	Trivandrum	
19	Shendurney	Thenmala	
20	Neduvathumuzhi	Konni	

ANALYSIS

The extent of damage is assessed in two ways, the number of plots raided (area of 10 sq. m) or the number of crops damaged. Their respective formulae are given below:

$$\begin{aligned}
 \text{i) Percentage of plots raided} &= \frac{\text{Number of plots damaged}}{\text{Total number plots}} \times 100 \\
 \text{ii) Percentage of crop plants damaged} &= \frac{\text{Number of plants damaged}}{\text{Total number of plants}} \times 100
 \end{aligned}$$

RESULTS

Protection methods and crop damage

The protection methods employed in different locations sampled in Kerala could be broadly classified into five categories:

1. GU+OF = Guarding with Ordinary Fencing: Fencing by various materials combined with guarding
2. SP = Special Protection: Crackers are used to scare away the animals
3. STW = Stonewall Fencing: Walls built around cultivated areas
4. CHE = Chemicals: Chemical repellents
5. EF = Electric Fence: High voltage electric fencing around the cultivated area

The effectiveness of the methods employed varied according to the locations (Table 2). Electric fencing, which was observed only in the Northern Circle was the most effective in the region. The Southern Circle employed a variety of protection methods, of which special protection followed by chemical repellants were the most effective.

Wild boar raided the most (52.5%) in guarded areas with ordinary fence, followed by elephant (41%) (Table 3). Crop raiding by other species individually or in combination was less in guarded plots with ordinary fencing. Special protection method employed in the Southern circle was not effective against wild boar. Stonewall fence was recorded only in the High Range circle, where all the plots were damaged by gaur. In areas where chemical repellents were used, the percentage of plots damaged by wild boar was high (78%). In electric fenced areas, the percentage of plots damaged by elephant was high (55%) followed by an elephant and wild boar combination (31%).

EVALUATION OF CROP PROTECTION METHODS

Table 2: Percentage of raided plots under different protection methods

S. No	Circles	Protection methods					No. of plots laid
		GU+OF	SP	STW	CHE	EF	
1	Northern	37 (46.25)				29 (36.25)	80
2	Olavacode	49 (62.25)					80
3	Central	28 (35.00)			8 (10.00)		80
4	High Range	14 (17.5)		16 (20.00)			80
5	Southern	32 (40.00)	10 (12.5)		15 (18.75)		80
Total		160	10	16	23	29	400

Figures in parentheses denote percentages

An attempt was made to analyse the effectiveness of various protection methods applied at locations on the periphery and in the enclosure (Table 4). The percentage of plots raided by wild animals was higher on the periphery (43%) compared to those in the enclosures (37%) in the locations guarded with ordinary fencing.

DISCUSSION

The highest numbers of plots damaged were in the periphery of the forest followed by the enclosure. The high incidence of crop raiding on the periphery, as well as in the enclosures, indicates greater risk and high probability of crop raiding in areas adjacent to wildlife habitat edges (Dudley *et al.* 1992).

Effectiveness of various control measures has been one of the important topics of debate in recent times. Control measures of long-term and short-term effects have been employed worldwide (Sukumar 1986; Schultz 1988; Santiapillai and Jackson 1990; Thouless and Sakwa 1995a; Bist 1996). The efficiency of the methods is reported to vary, depending on several factors including the raiding animal.

Protection methods prevalent in different locations in Kerala and their effectiveness vary only to a lesser extent.

However, the efficiency of the methods varies considerably with the raiding animals. This necessitates the development of new, innovative, eco-friendly, socially acceptable and cost effective long term solutions which are effective against most of the crop raiders.

Crop Protection Methods used in Kerala

The farmers employ a variety of protection methods, which can be classified as follows:

1. Guarding and Ordinary Fencing: In 45 settlements, crops were guarded at night from machans or platforms on top of rocks or trees. Wild animals were scared off by noisily beating on metal tins, and by torchlight and fire. This method requires vigilance throughout the night. In most places, firewood or old tyres are used to light fires at night. Electric bulbs are also installed in the field. Dogs are used to detect and chase off wild animals, and to alert the guards.

Coloured cloth and plastic bags are tied to poles and scarecrows used in the field to scare off raiding animals. When the wind blows, the sound of the plastic bags scares the raiders away. Arecanut or palmyra sheaths are tied to the trees for the same purpose. Cacti are planted along the boundary of the crop field as deterrents. The field is surrounded with fences of thorny branches of bamboo,

Table 3: Percentage of plots raided under different protection methods by different wild animals

S. No.	Animals	Protection methods					Total
		GU+OF	SP	STW	CHE	EF	
1	Elephant	66 (41.25)				16 (55.17)	82 (34.45)
2	Gaur			16 (100)			16 (6.72)
3	Sambar	1 (0.63)			1 (4.35)		2 (0.84)
4	Wild Boar	84 (52.50)	10 (100)		18 (78.26)	4 (13.79)	116 (48.74)
5	Elephant + Wild Boar	5 (3.13)				9 (31.03)	14 (5.88)
6	Elephant + Bonnet macaque	1 (0.63)					1 (0.42)
7	Sambar + Wild Boar				1 (4.35)		1 (0.42)
8	Chital + Wild Boar				3 (13.04)		3 (1.26)
9	Wild Boar + Porcupine	3 (1.188)					3 (1.26)
Total		160 (100)	10 (100)	16 (100)	23 (100)	29 (100)	238 (100)

Figures in parentheses denote percentages

Table 4: Percentage of plots raided by wild animals on the periphery and in the enclosure under different protection methods

S. No.	Protection methods	Plots damaged	
		Enclosure n = 200	Periphery n = 200
1	Guarding + Ordinary fence	74 (37.00)	86 (43.00)
2	Special protection	10 (5.00)	-
3	Stone wall	7 (3.50)	9 (4.50)
4	Chemicals	10 (5.00)	13 (6.50)
5	Electric fence	10 (5.00)	19 (9.50)
Total		111	127

Figures in parentheses denote percentages

Acacia, and *Zizyphus* to prevent the smaller mammals and cattle from getting in. Closely tied wooden poles act as a barrier to wild boar and deer. Such barriers are located in many places in Kerala. Four or six rows of metallic wires are stretched all along the boundary to keep out deer and wild boar. These are effective only to a certain extent as the animal may jump over the fence. Fences of 10-12 rows of barbed metallic wires are installed all along the boundaries of the field. The wire is fixed crosswise. This kind of fence was recorded in most places during the survey. The sound and light of crackers scare the animals away. Burning torches are thrown at the animal leading to injury, but this is not done at most places.

2. **Stone wall:** Only two settlements had stone walls to protect crops. The wall was built with rough-cut pieces of rock and stone, held together with cement, and was 1 m wide at the base, 0.5 m on top, and 2 m high. During the study period a brick wall measuring 0.5 m at the base, 0.25 m on top, and 1.5 m high was built in the Pallanad check post and Anakalpetti settlements of Marayur Range. There were several instances of gaur jumping over the brick wall in Marayur. Angle irons with barbed wire were often fixed on top all along the stone wall, to prevent gaur from scaling the wall. A stone wall cost about Rs. 50,000-75,000 / km, while a brick wall cost Rs. 40,000-50,000 / km.

In Kuppady of Sulthan Bathery range, a stone wall of about 3 km was built by the Forest Department all along the tar road to stop elephants from entering the settlements. In some places, especially in Peppara Wildlife Sanctuary, farmers had made rubble walls c. 1 m high and 0.5 m wide without cement to keep out smaller mammals, but it was not effective against elephants.

3. **Line cracker:** Line cracker is a special protection method recorded from four settlements during the study period. A metallic wire of small gauge is extended all around the field at a height of 0.5 m, and one end of this line is tied to

a stone with crackers. When an animal touches the line, the device gets loose and the crackers hit another stone on the ground below the device, and explode. The sound alerts the farmer on guard and also deters the animal. The method is widely used throughout Kerala and is reported to be effective against most animals, especially elephant and wild boar.

4. **Chemicals:** In three settlements, the farmers were using chemicals for protection. The smell of pesticides, such as Forite and Furadon repels the animal away from the crop field. It is effective against wild boar, but was found effective for only a week in Karingayam Kavu of Chimmomy Wildlife Sanctuary. In some places, naphthalene and phenol are used to repel elephants.

Kerosene or waste oil is poured along the possible entries of smaller animals, such as porcupine, black-naped hare and mouse deer. Kani tribes in Peppara Wildlife Sanctuary tie cloth soaked in kerosene to a pole and fix them in the field. Toilet or washing soap is kept in a coconut shell or tied to a stick and installed in the field. In the cold atmosphere, the soap gets wet and its fragrance helps to keep smaller mammals away from the field. However, when this method was tried in Perumalai in Marayur, the animals kept away from the field for only a few days, as they got used to the smell. Replacement after a short break had the same effect.

5. **Trenches:** Elephant proof trenches, 2 m deep, 3 m wide at the top and 1 m at the bottom have been dug in Wynaad and found to be effective against elephant, gaur and wild boar. Such trenches cost about Rs. 50,000 / km and require annual maintenance. Trenches are not feasible in areas with loose soil and high rainfall.

6. **Electric fence:** Electric fencing was recorded in only three settlements. The method is widely used the world over and is reported to be effective against most animals, depending on the number of wires used. The electric power fences are normally c. 150 cm high with 3 to 4 wires c. 30 cm apart. They require good maintenance, vegetation in contact with the wires has to be removed. Further, though the fence was reported effective against elephants, tuskers reportedly use their tusks or poles to break the wires. More often, the fence acts as a psychological barrier once the animal has felt a shock from one encounter. In Kerala, about 120 km of electric fences have been erected around settlements at various locations in Wynaad. Electric fences have also been erected in Neyyar and Peppara Wildlife Sanctuaries.

An evaluation of the methods used in Kerala is given in Table 5. Most methods are not suitable against all the animals and those effective against a single animal, are not necessarily cost effective. The selection of a method would depend on the site, raiding animal and funds available.

EVALUATION OF CROP PROTECTION METHODS

Table 5: Evaluation of crop protection methods in Kerala

Methods	Advantages	Disadvantages
Watchman (guarding at night from machans, huts on ground or rocks)	Immediate effect. Can be used in combination with ordinary fencing	High wages, animals, mainly elephant and gaur, become habituated and are dangerous for watchers
Sound making devices	Immediate effect. Can be used in combination with ordinary fencing, inexpensive	Animals become habituated
Lighting fires in the field using firewood, burning tyres or torches, and illumination with electric bulbs	Immediate effect. Can be used in combination with ordinary fencing, inexpensive	Animals become habituated
Olfactory (burnt chillies, toilet soap, smoke, repellents)	Immediate effect. Can be used in combination with ordinary fencing, inexpensive	Animals become habituated in short duration
Barriers (thorn fence, ropes, spikes, barbed wire, wooden poles)	Easy to construct, very effective against small mammals	Expensive, may cause injury to the animals. Not very effective against larger animals.
Missiles (spears, arrows)	Deterrent, not usually fatal to animals	Expensive, may injure the animals, wounded animals become aggressive
Pet dogs	Alert the man on watch	Elephant may get aggressive, chase dog, and may turn out to be detrimental to man on watch
Unpalatable vegetation barriers (Cacti, <i>Hibiscus</i> sp., eucalyptus, etc.)	Easy to grow, less expensive	Not effective against all animals
Stone wall	Little maintenance required	Limited effect, material not easily available, very expensive
Trenches	Very effective	High cost of construction and maintenance. Elephant can refill ditch. Not advisable in high rainfall areas with loose sandy soil.
Electric fencing	Rapid construction, design can be easily changed, very effective	Periodic maintenance required, high cost

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